

Lacertidae (Reptilia) de la zone thermomediterraneenne de l'est de l'Espagne. Aspects ecologiques. *Vie Milieu* 38:201-205.

—, —, and P. Navarro. 1986. Contribucion al conocimiento de la helminthofauna de los herpetos Ibericas. V. Parasitos de *Psammodromus algirus* (L., 1758) Boulenger, 1887, *Psammodromus hispanicus* Fitzinger, 1826 y *Acanthodactylus erythrurus* (Schinz, 1833) Mertens, 1925 (Reptilia: Lacertidae). Boletin de la Real Sociedad Española de Historia Natural Seccion Biologia 81:69-78.

—, E. Lopez-Balaguer, and M. J. Hornero. 1989. Helminthofauna de *Podarcis hispanica* (Steindachner, 1870) y *Podarcis bocagei* (Schoane, 1884) (Reptilia: Lacertidae) en el cuadrante noroccidental de la peninsula Iberica. *Revista Iberica de Parasitologia* 49:127-135.

Sharpilo, V. 1976. Parasitic Worms of Reptiles in the Fauna of SSSR. Izd. Naukova Dumka Kiev, Moscow. 287 pp. (In Russian.)

Specht, D., and M. Voge. 1965. Asexual multiplication of *Mesocestoides* tetrathyridia in laboratory animals. *Journal of Parasitology* 51:268-272.

Valenciennes, A. 1844. Observation d'une espèce de ver de la cavité abdominale d'une lézard vert piquete' des environs de Paris, le *Dithyridium laceratae*. *Comptes Rendus des Séances de l'Académie des Sciences Paris* 19:544-547.

Witenberg, G. 1934. Studies on the cestode genus *Mesocestoides*. *Archivio Zoologico Italiano* 20: 467-509.

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Research Note

Ectopic *Moniliformis moniliformis* from a Laboratory-Infected Rat, *Rattus norvegicus*

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ABSTRACT: An 11.3-cm gravid female *Moniliformis moniliformis* was removed from the greater omentum of a female outbred Sprague-Dawley rat 5 mo post-infection. Within the omentum, the worm was isolated in a host connective tissue tunnel in which there were inflammatory reactions and abscess formation. Eggs released by the worm elicited granulomatous reactions. Because lymphocytes were abundant throughout the omental tissue, with large areas of perivascular infiltration, it is suspected that the eggs of *M. moniliformis* in this extraintestinal site have antigenic components capable of stimulating a cell-mediated delayed hypersensitivity reaction.

KEY WORDS: Acanthocephala, ectopic, granuloma, *Moniliformis moniliformis*, omentum.

Necropsy of a laboratory-reared 9-mo-old outbred female Sprague-Dawley rat, fed 20 cystacanths of *Moniliformis moniliformis* (Bremser, 1811) Travassos, 1915, at age 4 mo, revealed a tumorous mass posterior to the stomach (Fig. 1). The approximately 2.5 × 1 × 1-cm mass appeared to be contained completely within a diverticulum of the greater omentum (Fig. 1). Examination revealed the presence of a worm looped throughout the mass (Fig. 1). The worm was removed intact and transferred to tapwater, in

which it exhibited slight, very sluggish motility. It was maintained in several changes of tapwater over a period of 2 days before fixation in alcohol-formalin-acetic acid and later processing as a whole mount stained with Mayer's carmalum. The remainder of the mass was fixed in neutral-buffered 10% formalin, postfixed in 70% ethanol, washed in running tapwater overnight, and processed for paraffin sectioning at 10 μm. Sections were stained with Harris's hematoxylin and eosin (Luna, 1968) as well as May-Grünwald stain, the periodic acid-Schiff reaction (PAS), Verhoeff's elastica stain, and Weigert's differential stain for fibrin (Thompson, 1966).

The parasite, an adult female *M. moniliformis*, was approximately 11.3 cm long. It did not become fully distended, nor did the proboscis evaginate, as expected after 2 days in tapwater. This may have been due to injury of the worm during its removal, or it might have been a reflection of reduced viability as a result of the host's response. In the whole-mount specimen, the tegument appeared friable and in some areas seemed to be sloughing. However, the ligament sacs of

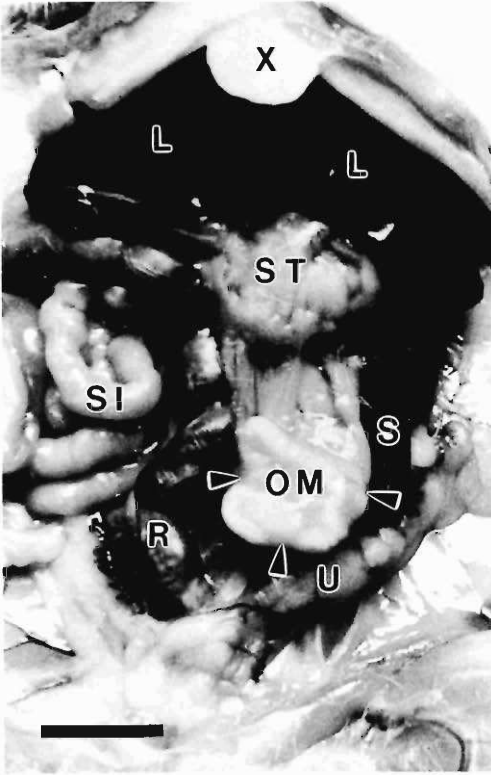


Figure 1. Photograph of ventral view of abdominal viscera and omental mass (pointers) containing *Moniliformis moniliformis*. Abbreviations: L = liver, OM = omental mass, R = rectum, S = spleen, SI = small intestine, ST = stomach, U = uterus, X = xiphoid process of sternum. Scale bar = 16 mm.

the worm were filled with fully developed, apparently viable eggs.

Histology of the mass was consistent with that of omentum. There were abundant white fat cells, blood vessels, and mononuclear cells. Mononuclear cells appeared to be mainly lymphocytes—frequently plasma cells, and occasional macrophages. Perivascular infiltration of lymphocytes was common throughout the sections. There were occasional eosinophils, and mast cells were found in clusters. A portion of the pancreas was incorporated in the diverticulum of the omentum. Whereas the majority of the tissues of the mass showed little postmortem necrosis, the acinar cells showed a degree of cloudy swelling with somewhat pycnotic nuclei. Whether this was the result of changes associated with the presence of *M. moniliformis* or truly postmortem necrosis could not be established; however, the

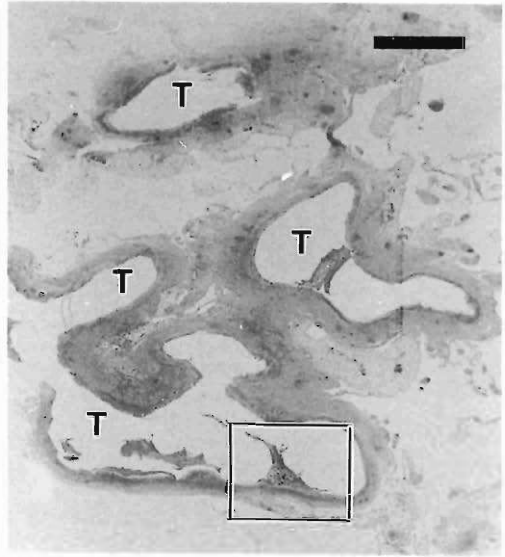


Figure 2. Macrophotograph of hematoxylin and eosin-stained paraffin section of omental mass. Area outlined by rectangle shown at higher magnification in Figure 3. Abbreviations: T = tunnel that contained the female *Moniliformis moniliformis*. Scale bar = 2 mm.

latter is most likely because approximately 30 min lapsed from the time of death until fixation of the mass.

The most striking pathological feature of the

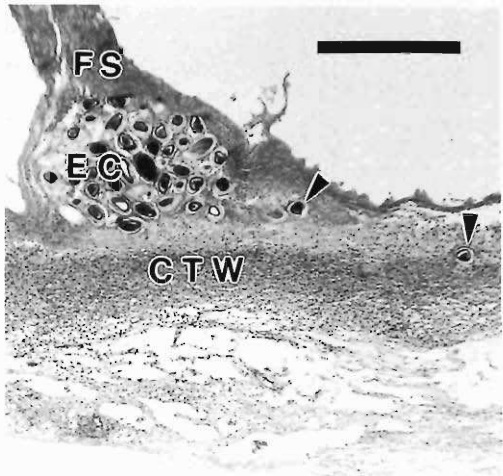
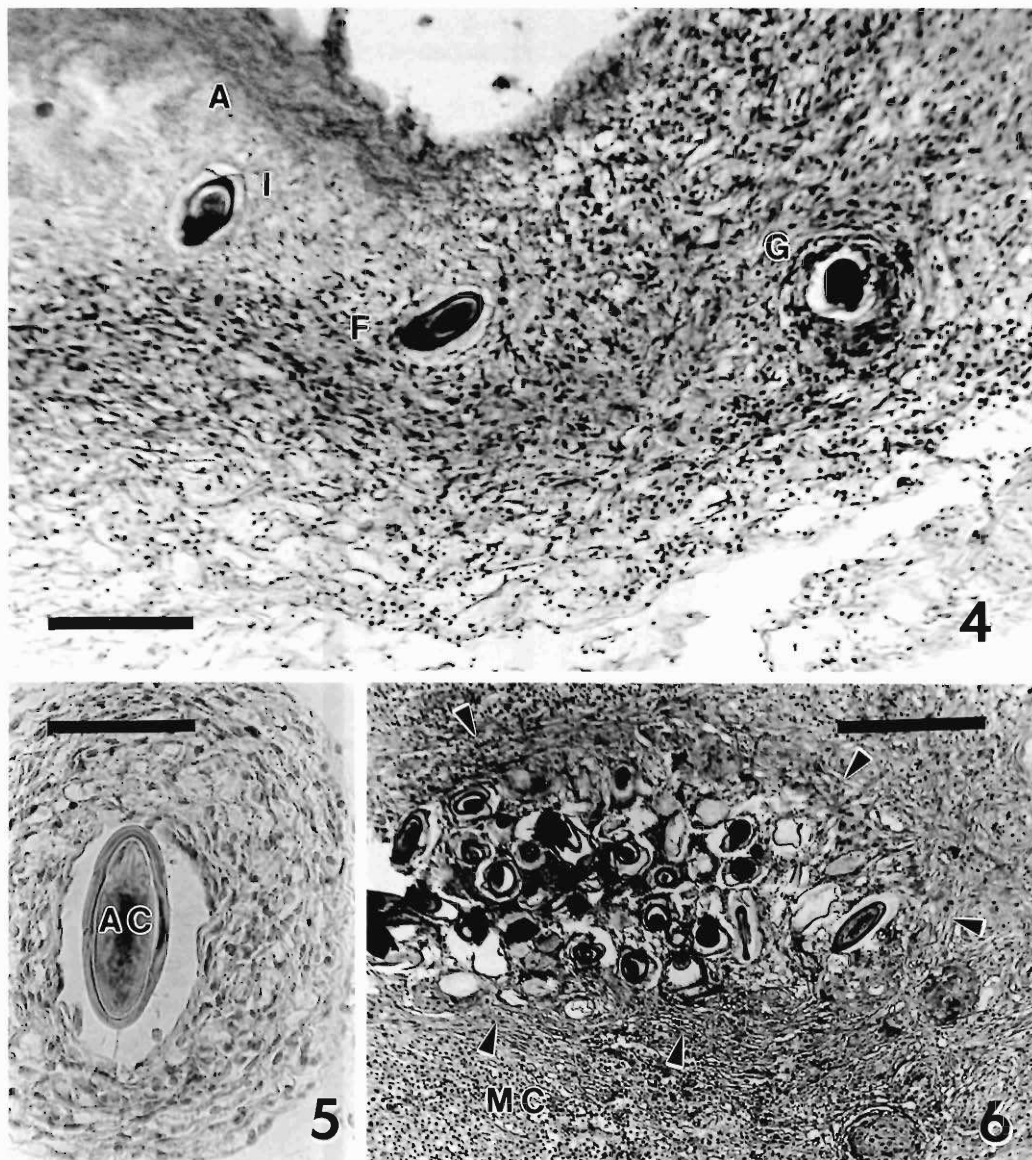


Figure 3. Photomicrograph of region noted in Figure 2 with fibrinoid substance protruding into the tunnel and a sequestered clump of *Moniliformis moniliformis* eggs. Pointers indicate individual eggs in stages of granulomatous reactions. Abbreviations: CTW = connective tissue wall of worm tunnel, EC = egg clump, FS = fibrinoid substance. Scale bar = 0.4 mm.



Figures 4–6. Photomicrographs of granulomatous reactions to *Moniliformis moniliformis* eggs. 4. Three eggs in different degrees of granuloma formation (Verhoeff stain). Scale bar = 0.2 mm. 5. Longitudinal section of a large granuloma containing a fully formed acanthor (hematoxylin and eosin stain). Scale bar = 0.08 mm. 6. A clump of eggs in the fibrous stage of granulomatous reaction. Pointers indicate areas of fibers (Verhoeff's stain). Scale bar = 0.2 mm. Abbreviations: A = region of abscess reaction, AC = acanthor, F = fibrous stage, G = completed granuloma, I = inflammatory stage, MC = mononuclear cells.

M. moniliformis-associated mass was the presence of a tunnel (Fig. 2), the site occupied by the worm, throughout the sections. The tunnel was surrounded by connective tissue, rich in collagen fibers. Within the tunnel there were occasional accumulations of numerous, apparently dead

polymorphonuclear leukocytes (PMN's) peripheral to large areas of a PAS-positive fibrinoid substance (Fig. 3). Thus, the worm appeared to have evoked a fibrino-purulent inflammatory host response.

Embedded among the PMN's and in the fi-

brinoid material are *M. moniliformis* eggs occurring singly and in small clumps (Figs. 3–5). As eggs occurred closer to the connective tissue margin of the tunnel (Fig. 3), they were subjected to granulomatous reactions. Such granulomatous reactions were most obvious for single, isolated eggs (Fig. 4, 5) but also were seen in response to clumps of eggs (Fig. 6). All stages of granuloma development (abscess formation, inflammatory stage, and fibrous stage) described by Hirata et al. (1993) for eggs of *Schistosoma japonicum* in the livers of mice were identified in sections of the omental mass containing *M. moniliformis*.

Several studies have demonstrated granulomatous reactions to acanthocephalans. Abe (1973) described the response to acanthocephalan proboscides in the submucosa of the pyloric cecum of rainbow trout. Taraschewski (1989) studied the reaction to dead, disintegrating *Acanthocephalus anguillae* in the peritoneal cavities of goldfish and carp. However, the present report is the first description of granulomatous reactions to acanthocephalan eggs. Inflammatory responses resulting in granuloma formation can be classified as either foreign body granuloma or infectious (or hypersensitivity) granuloma (Kellermeyer and Warren, 1970). Characteristic of each response are the development rate of the granuloma, the types of cells involved, and a variety of biochemical and immunologic determinations (Kellermeyer and Warren, 1970). Although the rate at which granuloma to *M. moniliformis* eggs develop is not known, the large accumulations of lymphocytes indicated that the response could have been cell-mediated delayed hypersensitivity, but experimental verification is necessary.

This is the first report of a gravid adult female *M. moniliformis* occupying an extraintestinal site in its definitive host. Varute and Patil (1971) described *Moniliformis dubius* (= *M. moniliformis*) in 6 of 30 moderate to heavily infected rats as causing perforations of the ileum with worms protruding into the abdominal cavity. The small intestine of the female rat in the present report contained no other worm and there was no gross sign of perforation damage along the wall of the small intestine. Because no ectopic male *M. moniliformis* was found and the female was gravid, it seems likely that the worm moved from the small intestine after insemination (as early as 16 days postinfection [Crompton, 1974]). A fixed, turgid female *M. moniliformis* at 15 days post-

infection is approximately 30 mm long and 0.7 mm wide (D. F. Oetinger and J. Essepian, unpubl. data). A worm this size could have moved to the pancreas and subsequently the omentum via a pancreatic duct, as has been reported (Popp and Schuster, 1989) for *Filicollis anatis* in its mallard host *Anas platyrhynchos*. However, Crompton (1974) indicated that full patency of a female *M. moniliformis* may require contact with 1 or more males over a period of 5 wk. A 50-day-old female *M. moniliformis* is approximately 162 mm long and 1.85 mm wide (D. F. Oetinger and J. Essepian, unpubl. data), probably too large to move through a rat pancreatic duct.

That ectopic *M. moniliformis* has not been reported from rats previously may reflect a phenomenon that is more common in female hosts but has not been noted because most experimental work with moniliformids has been conducted with male rats. Those researchers who use female animals should be aware of the possibility that extraintestinal movement may explain the greater intestinal loss rate of worms from female rats such as reported by Crompton and Walters (1972).

Literature Cited

- Abe, I. 1973. Histopathological observations on granuloma caused by acanthocephalan infections in rainbow trout. *Fish Pathology* 7:97–102. (In Japanese.)
- Crompton, D. W. T. 1974. Experiments on insemination in *Moniliformis dubius* (Acanthocephala). *Parasitology* 68:229–238.
- , and D. E. Walters. 1972. An analysis of the course of infection of *Moniliformis dubius* (Acanthocephala) in rats. *Parasitology* 64:517–523.
- Hirata, M., M. Kage, M. Takushima, and T. Fukuma. 1993. Different courses of granulomatous reactions around *Schistosoma japonicum* eggs in three strains of mice. *Journal of Parasitology* 79:266–273.
- Kellermeyer, R. W., and K. S. Warren. 1970. The role of chemical mediators in the inflammatory response induced by foreign bodies: comparison with the schistosome egg granuloma. *Journal of Experimental Medicine* 131:21–39.
- Luna, L. G. 1968. *Manual of Histologic Staining Methods of the Armed Forces Institute of Pathology*, 3rd ed. McGraw-Hill Book Company, New York. 258 pp.
- Popp, Von A., and R. Schuster. 1989. Verminöse pankreatitis bei *Anas platyrhynchos*. *Angewandte Parasitologie* 30:193–194.
- Taraschewski, H. 1989. *Acanthocephalus anguillae* in intra- and extraintestinal positions in experimentally infected juveniles of goldfish and carp

and in sticklebacks. *Journal of Parasitology* 75: 108–118.

Thompson, S. W. 1966. Selected histochemical and histopathological methods. Charles C Thomas, Springfield, Illinois. 1,639 pp.

Varute, A. T., and V. A. Patil. 1971. Histopathology

of alimentary tract of rats infected by *Moniliformis dubius* (Acanthocephala): Part 1—Histological alterations and changes in nuclei and mucopolysaccharide distribution. *Indian Journal of Experimental Biology* 9:195–199.

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Electronic Directory of Parasitologists

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The directory is currently available via an anonymous ftp site, and it is updated on a regular basis. To access the directory files, ftp to "magnus.acs.ohio-state.edu." Enter "anonymous" (no quotes) for your "username" and your e-mail address for the "password." To get into the appropriate directory for accessing the files, enter "cd<space>/pub/zoology" (no quotes) and press <return>. Once you are in the zoology directory you can list the files (to check the dates of the latest update) by entering "ls" (no quotes) at the ftp> prompt.

The names of the files in the directory indicate the date (MM_DD_YY) the files were last updated, and the directory is provided in several ready-to-use formats. The formats are indicated by the appropriate file name extensions, including dBASE IV (.DBF), Reflex 2.0 (.R2D), Lotus 1-2-3 v2.0 (.WK1), Quattro Professional (.WQ1), Symphony (.WRK), and Paradox (.DB). These are all binary files. The directory is also provided as an ASCII file (.TXT) using quotation marks (") as the delimiters. For example, the file "03_30_94.WK1" would be a Lotus format last updated on March 30, 1994.

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